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Under the subject contract, a program was undertaken with the object of identifying the effectiveness of equivalent response learning techniques in the human learning process, with special attention to the potentialities for training and retraining of unemployed youths, older workers, and disadvantaged sections of the population. The experiment was concerned with the establishment of criteria for the implementation of a 2x3x4 factorial matrix to study the variables in question in various combinations. The experimental variables considered included the method of instruction (matrix factor = 2), the type of skill to be mastered (matrix factor = 3), and the characteristics of the learner (matrix factor = 4). Throughout the duration of the program to date, the experimenters have been plagued with malfunctioning of the teacher aid equipment so that, allied with the small size of the sample, the results cited in the final report are felt to be inconclusive. Nothing like the desired goal of the above matrix was realized. It is felt that substantial rewiring of the circuit coupling the power supply to the keyboards will have to be effected before the hypotheses presented for this program can be confirmed or refuted. (Author/GO)

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FINAL REPORT

Project No. 5-0006
Contract No. OE-5-85-070

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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EXPERIMENTAL PROGRAM

ON

EQUIVALENT RESPONSE LEARNING TECHNIQUES

January 1, 1969

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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January 1, 1969

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FINAL REPORT

SUMMARY

Under the subject contract, a program was undertaken with the objective being to identify the effectiveness of Equivalent Response Learning Techniques in the human learning process with special attention devoted to the potentialities for training and retraining of unemployed youths, of older workers and of disadvantaged sections of the population. The experiment was concerned with the establishment of the criteria for the implementation of a 2 X 3 X 4 factorial matrix to study the variables in question in various combinations. These variables included the method of instruction (= 2), the type of skill to be mastered (= 3), and the characteristics of the learner (= 4).

It was unfortunate that due to an almost continuous state of malfunction of the teacher aide equipment, severely limited results were obtained. Although, nothing like the 24 combinations were tested, some limited results were obtained which upon superficial review might indicate the advantage of conventional learning techniques over the ERL techniques. However, when these results are scrutinized in light of the small size of the sample and the equipment unreliability, it can properly be concluded that the hypotheses were hardly tested.

It is the feeling of the investigators that the program as originally conceived is still meaningful, and that with a moderate redesign of the teacher aide equipment, it could be possible for the ERL techniques to have a significant impact on the amelioration of the status of a segment of the unemployable population of this nation.

FINAL REPORT

INTRODUCTION

It is recognized that among the unfortunate by-products of the impact of automation on industry are the displacement of a large segment of unskilled people who were formerly gainfully employed, and the limitation on employment opportunities for those unskilled people wishing to enter or re-enter the labor market. Personnel prominent in these categories include older workers, unemployed youths, and disadvantaged sections of the population.

The experimental program undertaken was felt to offer a promising new approach to the training of such personnel in relatively sophisticated manual skills through the process of Equivalent Response Learning (ERL) Techniques. It was felt that these techniques would permit a trainee to acquire quickly the knowledge and skills required for keyboard operation of office and industrial equipment. In addition, through the use of ERL techniques, the learning time for such applications as typing, stenotyping, keypunch, comptometer, and adding machine operation could be reduced significantly from the training time required with conventional techniques.

The subject program is an outgrowth of a former program devised to train keyboard operators for high-speed mail sorting machines (U.S.I. Robodyne's "Digiflex"). In that system, the "Digiflex" monitor would flash postal addresses on a screen and electrical pulses caused the combination of keys that punch code numbers to use on student's keyboard. By this technique, the student operator was able to master a complicated scheme of symbolic information involving postal addresses and correlate this information with patterns of keys to be depressed on a ten-finger keyboard. The intellectual requirements for learning the scheme were high, but once the scheme was learned and facility in operating the keyboard was developed, the operator's performance was reflexive in nature and required very little intellectual application.

On the basis of this hypothesis, it was felt that the intellectual background required of the trainee to successfully grasp the skills cited above would be substantially lower utilizing ERL techniques than would be required by conventional techniques.

FINAL REPORT

METHODS

The study as undertaken was initially concerned with the design and construction of the teacher aide equipment. (It was the chronic failure of this equipment to function in a consistent and reliable manner that prevented the successful realization of the objectives of the design matrix cited below.)

Research emphasis was centered on an experimental investigation of conditions that facilitate or impede the learning of certain classes of skills. A factorial design was established whereby the variables in question could be studied in various combinations in one experiment. The factorial matrix was to be 2 X 3 X 4 as follows:

The first experimental variable was the method of instruction. This variable would allow ERL techniques to be compared with conventional instruction (matrix factor = 2).

The type of skill to be mastered was to provide the second variable. This was to be varied in three ways (matrix = 3). Learning to operate a ten-finger keyboard represented one experimental condition. Learning a specific skill (key punch operation) represented a second condition. Learning to associate appropriate psychomotor responses with symbolic material in order to learn the material constituted the third condition to be studied.

The third variable involved the characteristics of the learner. Four classes of subjects were prescribed for participation in the study as follows (matrix factor = 4):

(1) Students who have earned the equivalent of a degree of the Associate in Applied Sciences.

(2) Unemployed youths of approximately the same intelligence level, ability and age as above.

(3) Older people in the 45-50 year range up for job retraining.

(4) Disadvantaged people, approximately 30 years of age who have not been able to hold other than menial jobs.

The criteria for learning were to consist of three measurable dependent variables. This first was to consist of immediate gains in achievement as measured by scores on a proficiency test administered to all subjects at specified points in the training program as well as by the length of instructional time required to achieve an established level of mastery. As a second dependent variable, the study was to permit an evaluation of the amount of transfer of learning associated with each of the two methods of instruction. The third dependent variable was the establishment of the retentivity level of learned material for both learning techniques which would be determined by retesting the proficiency of the subjects at prescribed intervals after the acquisition of the original data.

The program as conceived provided for a design which was to make use of 60 matched pairs of subjects. The matching was to be based on socio-economic background, IQ, and initial ability with respect to the skill to be learned. The 120 subjects were to be allotted to the 24 experimental learning conditions shown in Table 1. In this table, the three experimental variables are designated as A, B, and C.

Variable A ---Method of instruction will be varied in two ways; the pairing of subjects will take place with respect to this variable.

Variable B ---Type of skill to be mastered has three subclasses.

Variable C ---Type of subject consists of four subclasses as described above; it can therefore be varied four ways.

Table 1.

FACTORIAL DESIGN

		C_1	C_2	C_3	C_4	TOTAL
A_1	B_1					20
	B_2					20
	B_3					20
A_2	B_1					20
	B_2					20
	B_3					20
		30	30	30	30	

Scores on each dependent variable to be obtained under the various experimental conditions were to provide the data to be analyzed. Five persons were scheduled to be assigned each experimental condition.

The factorial design as outlined was felt to permit statistically significant statements to be made about the general effectiveness of ERL techniques compared with conventional instruction. It has the added advantage of highlighting the relative importance of each variable with respect to the others. These experimental findings would also be useful in specifying the conditions that aid or hamper learning. It would then be possible to translate the findings into specific recommendations for increasing the effectiveness of training programs for a wide variety of commercial skills.

PROCEDURES

The procedures employed in the study have been documented in the quarterly reports which were prepared at intervals throughout the duration of the project. The five most significant quarterly reports, containing the bulk of the substantive reporting, will be found in the Appendices to this final report.

RESULTS AND FINDINGS

The material presented herein is tempered by the fact that the unreliable operation of the teacher aide equipment prevented the investigators from achieving their desired objectives. These objectives as originally contemplated may be summarized as follows:

(1) To identify the effectiveness of ERL techniques in the human learning process.

(2) To compare the results of ERL techniques against conventional approaches on a pilot sample of subjects (some 120 subjects was established for these pilot tests).

(3) To determine the potentialities for training and retraining unemployed youths, older workers, and certain disadvantaged sections of the population by expanded ERL techniques.

Because of the difficulties cited above, the third item was not touched on at all while the first two items were but barely examined and in manner hardly deemed to be meaningful.

After succeeding in putting the teacher aide equipment in at least a functional state of operation, an attempt was made to determine the rate of skill development on a ten-finger keyboard by conventional and by ERL techniques. The unexpectedly high amount of time required to get the teacher aide equipment to function even marginally reduced the chance to fully implement the 2 X 3 X 4 matrix of variables. As such, only a limited number of subjects were able to be tested at all.

These subjects were matched on the basis of sex, educational background, previous experience on related types of equipment (i.e., typewriters, key punch machines, et al), and on the basis of scores achieved on a pre-test using the actual teacher aide equipment and a random code.

The training regimen for both the experimental and control groups consisted of presenting the letters of the alphabet with their corresponding codes in consecutive order from A through Z, followed by the letters mixed at random, further followed by the numerals from 1 through 9 with their corresponding codes in consecutive order, in turn followed by the numerals mixed at random. The actual sequence of events was as follows:

(1) Letters A through Z with corresponding codes in consecutive order.

(2) Letters mixed randomly starting with D.

(3) Numerals 1 through 9 with corresponding codes in consecutive order.

(4) Numerals mixed randomly starting with 4.

The measurement criterion was established as the total number of trials an individual required to learn the code without any errors. This included the situation where the symbols were mixed at random.

This information was obtained by administering tests after a designated number of trials. As a subject completed a test successfully, i.e., no errors recorded, he was moved ahead to the next test which was increased in complexity progressively. For example, after subject #1 achieved a zero error score on the test of the coded information corresponding to the letters of the alphabet from A through Z in consecutive order, a test was administered with the stimulus letters mixed at random starting with the letter D. Very often, a subject was able to achieve a zero error score for the consecutive letter test but made several errors when the letters were mixed. In that event, several tests were necessary before the subject was able to reach the zero error proficiency level for the more difficult case.

When this phase of the test was successfully completed, trials on the numerals followed with the same procedures as above followed. When the subject achieved the zero error criterion for both mixed numbers and letters, it was concluded that he successfully learned and was able to retain the complete code of 35 symbols (26 letters and 9 numbers).

The level of proficiency for each subject was measured by the total number of trials he required to learn the entire code (mixed as well as in consecutive order).

The above procedure was varied using a matched pair of subjects, and a variation in the presentation of the information. The score for this test is presented in Table 4. In these tests, instead of the letters being presented in consecutive order each trial as was done with the major group of subjects, the alphabet was broken down into two parts, A to M and N to Z. Consequently, a trial in this instance consisted of presenting but 13 letters instead of 26. After having learned the code from A to M, the subjects moved on to master the letters from N to Z. In the end, both parts of the alphabet were combined and then mixed randomly as was done with the major group (see Table 2). This procedure represented but a slight variation from the procedure followed for the major group of subjects involved. As stated above, only two matched subjects were administered the regimen with this variation. The level of proficiency for this pair was also the number of trials it required for them to learn the entire code. As seen from Table 3, their scores could easily be projected into the respective distribution of the major group of subjects.

An analysis of the results of the limited number of tests given the major group of subjects is presented in Table 2.

Table 2.

SCORES FOR GROUP A — EXPERIMENTAL		SCORES FOR GROUP B — CONTROL	
Subject No.	Criterion Score	Subject No.	Criterion Score
1	38	1'	15
2	30	2'	30
3	28	3'	35
4	26	4'	25
5	22	5'	25

The '(prime) designation represents the matched subject for the control group.

Mean of Group A..... = 28.8
Median..... = 28
Range..... = 16
Standard deviation from the mean,... σ = 5.93
Standard error of the mean,..... σ_{m} = 2.64

Mean of Group B..... = 26.0
Median..... = 25
Range..... = 20
Standard deviation from the mean,... σ' = 7.41
Standard error of the mean,..... $\sigma_{m'}$ = 3.30

Student's t test of difference between

means (t) = 0.660 ($P > 0.05$)

The t test is presented here although for such a small sample size, t tests are not usually applicable.

The results of the experiment are felt to be inconclusive for two principal reasons:

(1) the small size of the sample
(2) equipment malfunction

It is patently obvious that drawing any statistical inference on the basis of so small a sample of subjects is dangerous. In addition, the deficiencies in the equipment design coupled with the equipment malfunctions literally destroyed at the outset of testing the hypothesis reliably and validly.

Some examples of equipment deficiency and malfunction observed before and during actual experimentation were:

(1) In the experimental condition, when any combination of keys involving the right hand was involved, the keys popped up twice in the same cycle. This represented an extreme distraction, as expressed by the subjects themselves, so that instead of the stimulation facilitating the learning process, the popping phenomenon rather militated against it.

(2) In both the experimental and control conditions, as the correct code was indicated either visually or through the sensory stimulation of the fingers, and the correct combination of keys was depressed, it was necessary for the subject to keep those keys depressed for at least 3 full seconds lest an error be recorded.

(3) Another drawback in terms of equipment functioning was the fact that when the subjects in either test condition depressed the correct combination of keys, a loud sound resulted. This sound occurred only when the correct combination of keys was depressed. During the testing situation, this sound became an uncontrolled cue for the subject as he consciously listened for the sound to corroborate his choice of keys. This coupled with the fact that the error counter did not lock instantly as a combination of keys was depressed, but rather locked some 4 seconds after the start of the cycle, essentially allowed the subject some 4 seconds in which to seek the correct combination with immediate feedback coming from the sound cue should he have chosen the proper combination.

(4) Unreliability of the dials which controlled the stimulus duration, viewing time et al which resulted in uncontrolled variations from trial to trial.

(5) At times, the error counter failed to function at all.

Table 3.

Additional Scores in Experimental Group Without a Control Match (due to failure of matched subject to appear after the first day of testing)

GROUP A

EXPERIMENTAL

Subject No.	Criterion Score
6	16
7	28

Table 4.

Scores of the Special Two Matched Subjects Following Varied Techniques

GROUP A		GROUP B	
EXPERIMENTAL		CONTROL	
Subject No.	Criterion Score	Subject No.	Criterion Score
8	22	8'	18

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the obviously limited statistical data generated up to the time this report was prepared, one might come to the conclusion that the conventional approach to learning the designated code was slightly more effective than the ERL technique. This, of course, must be qualified greatly due to the limited sampling of subjects and the more significant factor of teacher aide equipment malfunction. If one were to make a positive conclusion, it would have to be that the hypotheses simply have not been tested in any manner consistent with making any conclusion.

It is regrettable that a mere segment of the overall objectives of the program was able to be touched upon. It is the feeling of the investigators that the validity of the hypotheses is yet to be affirmed and can only be done so with a program conducted in a manner consistent to what was originally drawn up.

To accomplish this, a major revision of the coupling of the power supply to the ten-finger keyboards would have to be undertaken. Steps for doing so had commenced up to the time the contract had expired. It is clear that an error in strategy was made in spending more than a year's time attempting to patch up a coupling system that was unstable and super-sensitive to begin with. This judgement factor came about when a subcontractor deviated from the course originally set and the investigators went along with the idea that the modifications were not complex by nature. This was not the case to the extent that this deviation in essence sabotaged the program.

The overall objective of using the ERL techniques to eventually help determine the potentialities for training and retraining unemployed youths, older workers and certain disadvantaged sections of the population is as meaningful and worthy of implementation today as it was when this program commenced.

With this in mind, it can be recommended that the project officer and an advisory panel once again consider the value of this program and its objectives without the jaundiced view of what was not accomplished because of the factors listed above. It is felt that a fresh approach, taking advantage of the knowledge gained from what was done in this experiment, could make an appreciable contribution to our underprivileged society.

APPENDICES

APPENDIX A. - Quarterly Progress Report No. 1

APPENDIX B. - Quarterly Progress Report No. 2

APPENDIX C. - Quarterly Progress Report No. 3

APPENDIX D. - Quarterly Progress Report No. 6

APPENDIX E. - Quarterly Progress Report No. 8

APPENDIX A.

Quarterly Progress Report No. 1

NEW YORK INSTITUTE OF TECHNOLOGY

APPLIED RESEARCH LABORATORY

Quarterly Progress Report No. 1

for an

EXPERIMENTAL PROGRAM

on

EQUIVALENT RESPONSE LEARNING TECHNIQUES

Contract No. OE-5-85-070

submitted to:

Division of Vocational and Technical Education
Office of Education
U. S. Department of Health, Education, and Welfare
Washington, D. C. 20202

period covered:

May 1, 1965 through July 31, 1965

submitted by:

Theodore K. Steele, Eng.Sc.D.
Principal Investigator

ABSTRACT

Under the above contract, the Applied Research Laboratory of the New York Institute of Technology is undertaking an experimental program on Equivalent Response Learning Techniques with the objective being to identify the effectiveness of ERL techniques in the human learning process with special attention devoted to the potentialities for training and retraining of unemployed youths, of older workers, and of disadvantaged sections of the populations. The period of time covered by this report was spent primarily in the organization of the program as well as the finalization of contractual matters. The report presents material concerned with the design of the Equivalent Response Learning Technique Test System, an analysis of the principal independent variables and a brief description of the methodology for classifying the research subjects.

INTRODUCTION

This quarterly report covering the activities of the New York Institute of Technology Applied Research Laboratory from May 1, 1965 through July 31, 1965 is primarily concerned with the design of the experimental teaching aids for the ERL Test System and the establishment of the criteria for the implementation of the 2 X 3 X 4 factorial matrix to study the variables in question in various combinations.

The unanticipated delay in the finalization of the contract has caused some delay in realizing of the sequence of events listed in the proposal. The limitation of available funds particularly slowed the purchase of equipment necessary to construct the teaching aids for the ERL Test System. It is hoped that an accelerated effort in this area during the second quarter can make up some of this lost time.

The first section of this report presents the design of the Equivalent Response Learning Technique Test System. Efforts have been made to utilize standard purchasable material for this system wherever possible. The sequential functioning of the system is presented in detail along with pertinent sketches.

The second section presents a discourse on the independent variables associated with the experiment. A recommended code for the initial instruction phase is outlined in considerable detail. A discussion concerning the transferability of skills and learning to associate appropriate psychomotor responses with symbolic material in order to learn the material follows.

The third section concerns the methodology for classifying the pairs of research subjects. This segment will be amplified further during the second quarter.

SECTION 1.

Equivalent Response Learning Technique Test System

The purposes of the ERL Test System are:

(1) To present on a screen, for viewing by the test subject, any information which we want him to correlate with a pattern of keys on his ten-finger keyboard.

(2) To raise certain keys against the subject's fingers (when the system is operated in the Stimulate mode), in a pattern corresponding to the information correlation scheme being used.

(3) To compare the subject's response with the desired response, in either the Stimulate mode or the Test mode.

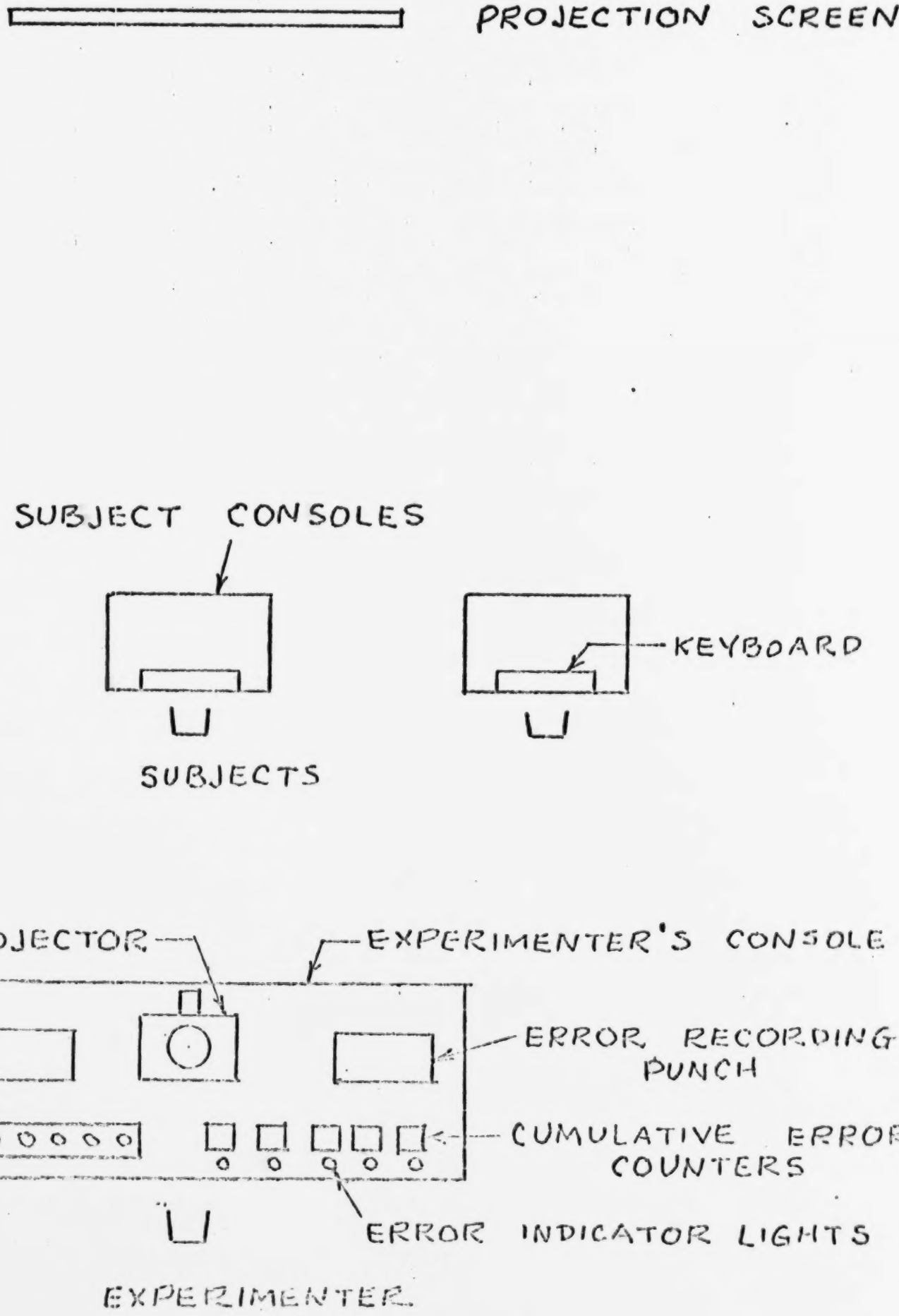
(4) To record errors in the subject's response, both individually and cumulatively.

(5) To provide the experimenter with control over the nature, sequence and timing of the information presented, and with instantaneous indication of each subject's accuracy of response.

FIGURE 1

CLASSROOM DIAGRAM

ERLT TEST SYSTEM



Operation and Sequencing of Equivalent Response Learning Technique Test System. (See Figure 2.)

(1) The Correct Signal Reader (CSR) is a paper tape reader which senses 10 rows of information (10 holes) simultaneously, and thus recognizes the keyboard patterns stored on the tape. These patterns correspond to visually presented information stored in the Slide Projector. The CSR generates a "closed-switch" output signal to operate the correct pattern of relays in the Transfer Relay Bank, corresponding to the information projected by the Slide Projector.

(2) If the Stimulate/Test Switch is placed in the Stimulate position, the signal pattern from the CSR is transferred to the Solenoids, and the Intermediate Keys are caused to operate in a corresponding pattern up against the fingers of the subject, and the same signal pattern is transferred to the Comparator contacts on the Transfer Relays. If the Stimulate/Test Switch is in the Test position then the pattern is transferred only to the Comparator logic.

(3) In the Stimulate Mode the upward pressure of the keys against the fingers of the subject and the muscular resistance stimulated causes the Manual Key to operate downward toward the Intermediate Key and shifts the Key Contact from position A to position B. It should be noted that although the Comparator is shown objectively in the block diagram the Logic is actually entirely contained in the wiring between the Comparator Contacts on the Transfer Relays and the Key Contacts operated by the Manual Keys (see Figure 3).

(4) In the Test Mode the circuits to the solenoids are opened by the Stimulate/Test Switch and the keys do not operate upward against the fingers of the subject. Thus the generation of an Equivalent Response pattern in the Key Switch contacts (in response to the visual signal projected by the Slide Projector) is entirely a function of the subject's own learned responses (i.e., is not elicited by key movements and resistive responses).

(5) The Comparator is a matrix connection between the Comparator Contacts on the Transfer Relays and the Key contacts operated by the Manual Keys, and is shown in Figure 3. This provides a signal to the Error relay if and only if the Correct Signal Reader output does not correspond to the Keyboard signal pattern generated by the subject's response.

(6) The "Now" Relay is operated through an appropriate Time Delay and causes the Error Relay signal to be observed by the Error Recording Punch and the Cumulative Error Counter at the correct time in the program.

(7) The Slide Projector is caused to advance -- and display new information -- by the output from the Manual Advance Switch or the automated Clock Advance Switch.

(8) The paper tape in the CSR is indexed to a new position by the same Manual Advance or Clock Advance Switch, through an appropriate Time Delay so that the Solenoids will be operated subsequent to the observation of the visual signal.

(9) The system once more moves through the sequence of events described above.

A detailed sketch of the key contacts is presented in Figure 4.

* * * * .

FIGURE 2.

FUNCTIONAL BLOCK DIAGRAM

ERLT TEST SYSTEM

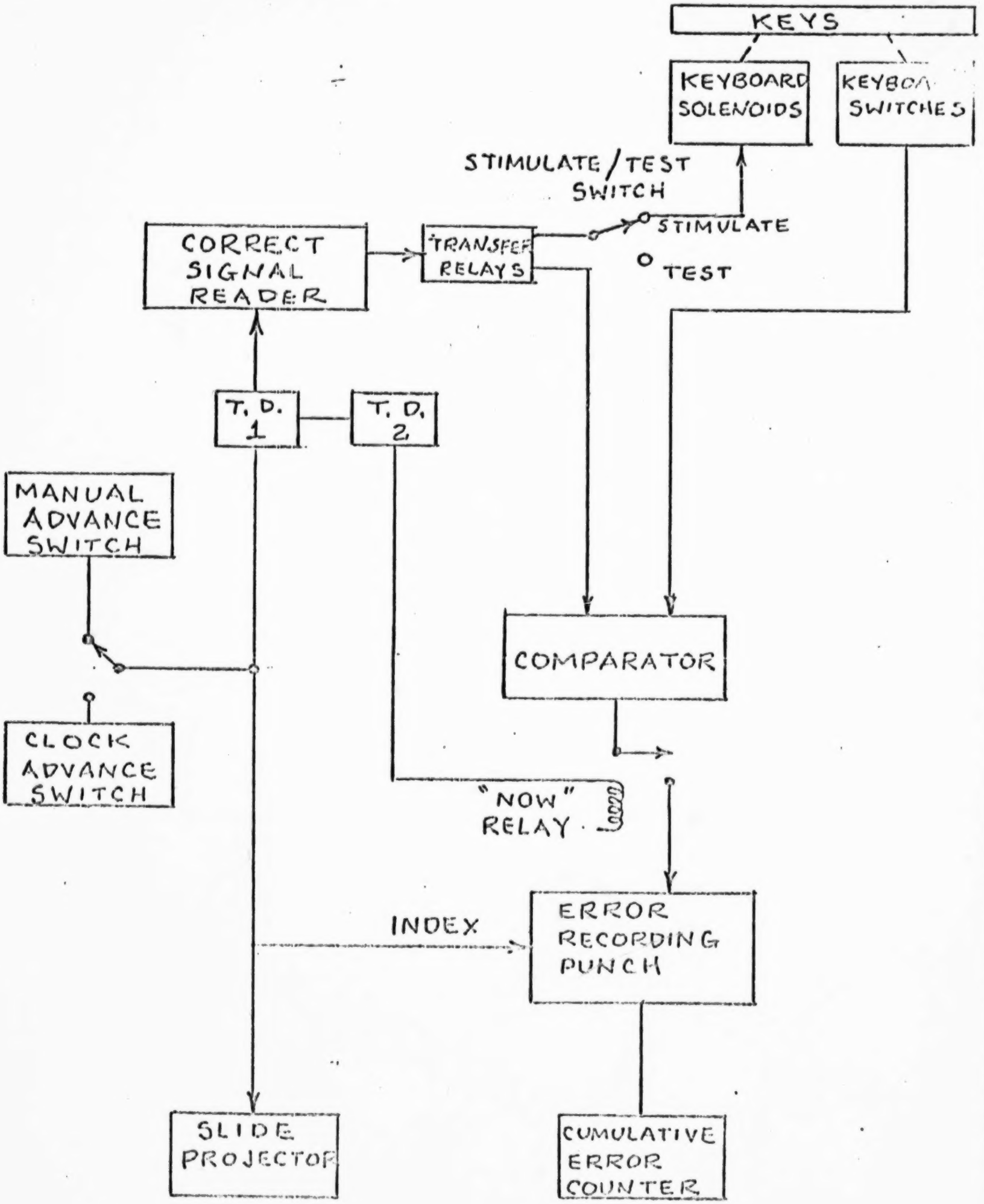


FIGURE 3

COMPARISON LOGIC CIRCUIT DIAGRAM

ERTL TEST SYSTEM

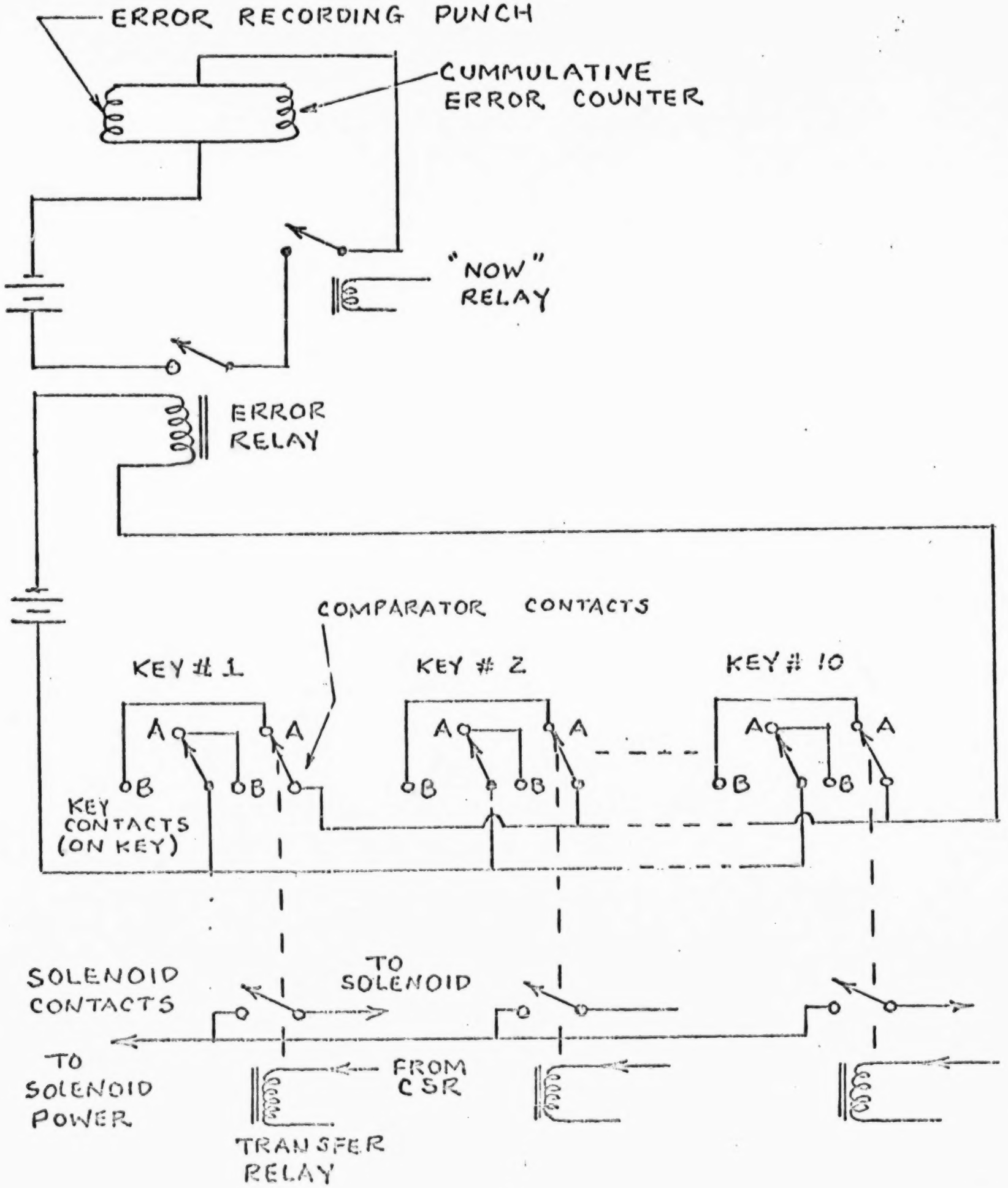
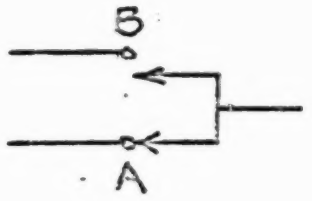


FIGURE 4

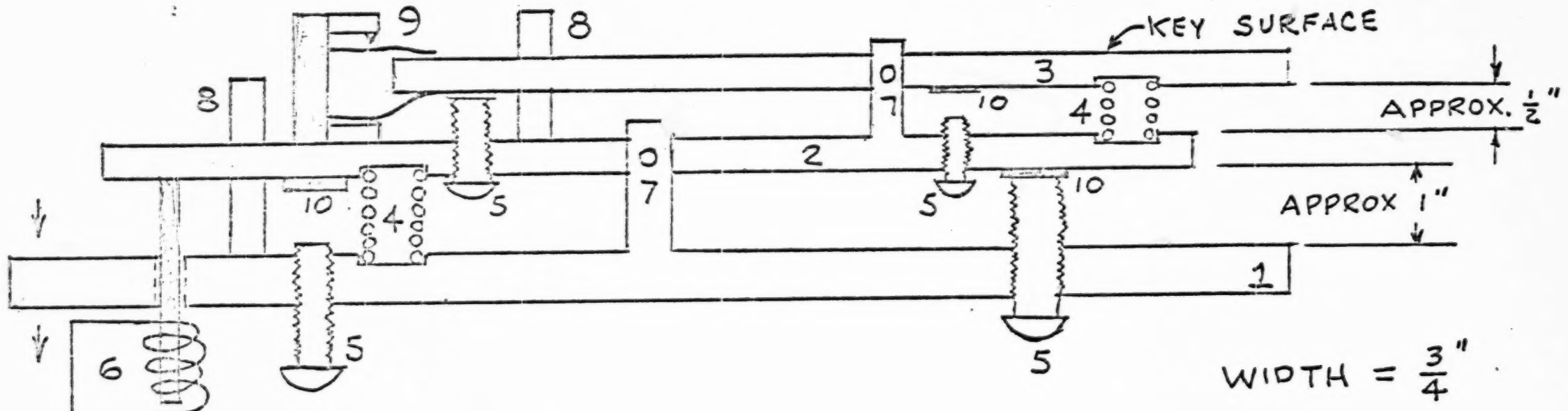
SCHEMATIC DIAGRAM OF INDIVIDUAL KEY

(TEN KEYS PER KEYBOARD)

ERTL TEST SYSTEM



KEY CONTACTS SCHEMATIC



1 DESK TOP - MECHANICAL GROUND
2 SOLENOID OPERATED INTERMEDIATE KEY
3 MANUEL KEY
4 RETURN SPRINGS
5 STOP ADJUSTMENTS
6 SOLENOID
7 PIVOTS
8 LATERAL GUIDE PINS
9 GANGED MICRO - SWITCHES (SCHEMATIC SHOWN ABOVE)
10 RUBBER BUMPERS

TO SOLENOID CONTACTS AND POWER

SECTION 2.

Concerning The Three Independent Variables

(1) The first experimental variable to be considered is the method of instruction. As indicated in the design, the method of instruction pertains to the kinds of tasks the subjects will be required to master, or more specifically, how the subjects will be taught to master these tasks. Operationally, the method of instruction can be defined as the way in which the information to be learned is presented to the subjects. There is contained in the initial design a brief discussion of the dichotomization of this variable so that Equivalent Response Learning could be compared with conventional instruction. For the most part, it has been determined that the only difference which can exist between the experimental and controlled condition is the cuing of the keys in the experimental condition. The maintenance of constancy in every other area, specifically in regard to the presentation of information and precise definition of the task involved is necessary in order to insure the validity of our findings.

At present, a screen on which the information to be learned will be projected, appears to be an appropriate method of instruction. This seems to be so by virtue of the fact that any other means of presenting information (as for example a practice book similar to those used in teaching the use of the typewriter), could not be indexed readily so as to produce the desired conditioned reflex in the experimental condition.

(2) The type of skill to be mastered provides a second variable. According to the design, this would be varied in three ways:

(a) Learning to operate a ten finger key-board.

(b) Learning a specific skill such as key-punch operation.

(c) Learning to associate appropriate psychomotor responses with symbolic material in order to learn the material.

The task presupposed in condition (a) is a basic mastery of the 10 finger key-board. Learning to operate a 10 finger key-board by manipulating various combinations of the 10 keys involved is not deemed to be an extremely difficult task. It lacks the difficulty inherent in condition (c), which requires learning to associate appropriate psychomotor responses with symbolic material in order to learn the material.

The keys in both condition (a) and condition (c) will be <u>blank</u>. In condition (a) the task involved as well as the method of presentation of information will proceed as follows: Various combinations of keys will be flashed on to a screen; the task of the subjects being to hit the correct combination of keys simultaneously. The subjects will be able to distinguish which keys to hit because the appropriate keys, when flashed on to the screen, will have an <u>X</u>, or some other distinguishing mark through them, as for example:

```
  0 0 X 0 0          0 X X 0 0
  L 1 2 3 4 5        R 5 4 3 2 1
```

As stated previously, the only difference between the experimental and the control condition will be the cuing of the keys in the experimental condition.

The level of difficulty of the task involved will increase as the subjects progress in training from relatively simple combinations of keys (0 0 0 0 0 ▪ ▪ 0 0 0), to much more difficult ones such as (0 ▪ 0 0 ▪ 0 ▪ 0 ▪ 0). It will be necessary for the sequence of keys flashed to move at a steady pace. The first dependent variable, consisting of immediate gains in achievement, will be measured by scores on a proficiency test administered after each fourth trial. The same set of instructions will be read or distributed to all of the subjects. There will be approximately from 8 to 10 trials of 40 minutes each (instead of 1 hour, in order to guard against possible fatigue). There will be a 10 minute practice session before each trial, primarily to relax the subjects. One trial per day for each group of 5 subjects should suffice. Consequently, for each subject, condition (a) could be run as a class of 50 minutes per day for 8 days. Ideally, 20 subjects could be accommodated per day (4 groups of 5 subjects each), which constitutes exactly ½ of the total number of 40 subjects alloted for this condition. For each session, 10 subjects would be members of the control group while the other 10 subjects would constitute the experimental group. Allocating 2 days at the end of the 8 days for analysis of the data, it would take 10 days (or 2 work weeks to be more precise) to run 20 of the subjects through all of their trials. Consequently, it would take another 2 weeks

to complete the trials on the other 20 subjects. Total running time on condition (a) should be about one month.

The third dependent variable, the establishment of the retentivity level of learned material for both techniques will be determined by retesting the proficiency of the subjects at about quarterly intervals after the acquisition of the original data.

The analysis above of condition (a) is a rational and reasonable explanation within the confines of speculation. However, it obviously lacks the empirical foundation so necessary in refining such speculative data. For purposes of our investigation this empirical foundation will be supplied in the form of a pilot study. The use of a pilot study (with a group of New York Tech students) is by far the most effective and appropriate means of solving some of the technical and practical problems which defy the use of reason alone. The pilot study, among other things, will prove helpful in determining such things as the amount of time per trial, per day, per condition, etc. Also, the use of an 8 or 16 mm movie camera to photograph the initial stages and process of learning the operation of the 10 finger key-board may prove very beneficial as a further adjunct to the pilot study.

Concerning condition (b) Learning a specific skill such as punch operation. What is of concern here is the problem of the transferability of skills. In order to validly test the transferability of skills, more than one key-board type operated machine should be used. Some skills transfer more

readily than others. For example, it may be that having had experience on the 10 finger key-board would facilitate the learning of an IBM card punch machine considerably, but would have little or no positive effect on learning to operate a conventional typewriter.

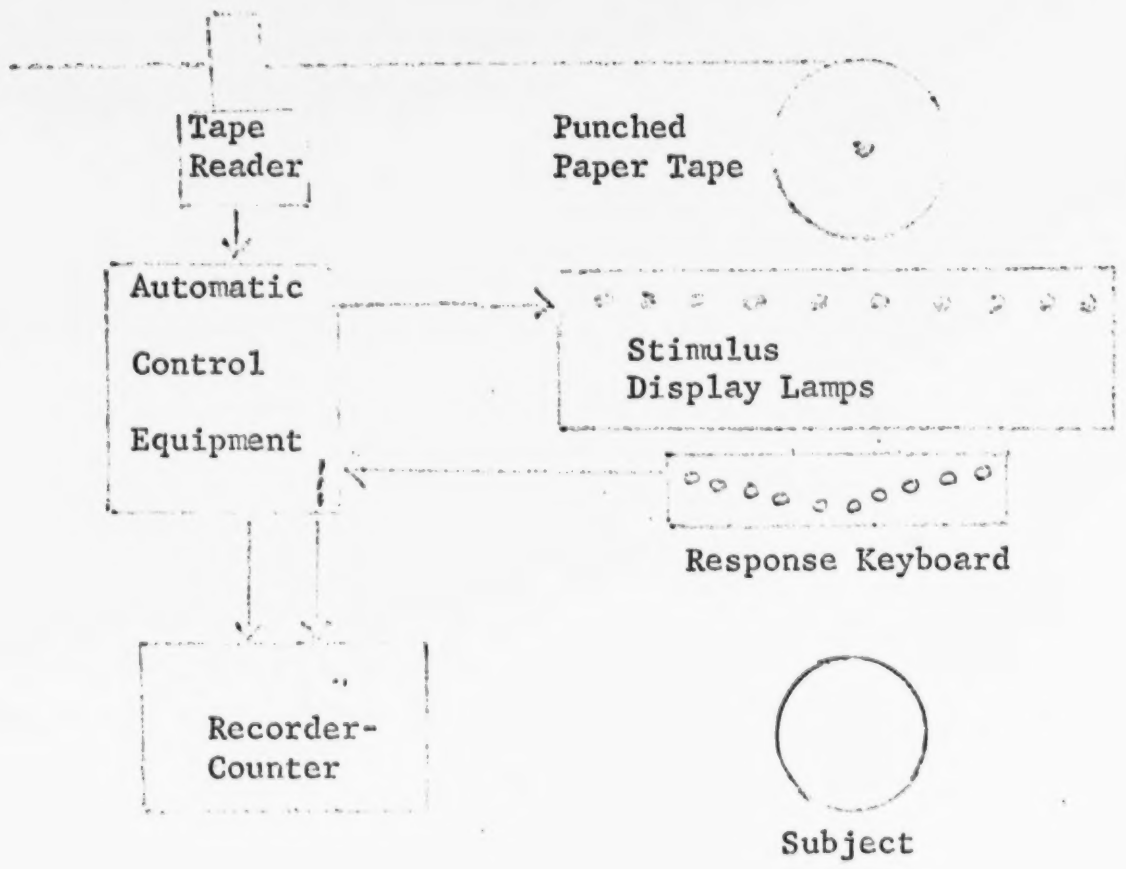
Concerning condition (c) Learning to associate appropriate psychomotor responses with symbolic material in order to learn the material. Setting up the learning procedure for condition (c) can be accomplished by the introduction of a code. It would be necessary for the subjects in both the control and experimental groups to memorize and learn this code (presumably, pending the results of condition (a), the ERL training technique should facilitate the learning of such a code).

It should be kept in mind that the keys in condition (c), as in condition (a), will be blank. This code would involve the matching of letters of the alphabet, numerals, and punctuation symbols with various combinations of the 10 keys on the 10 finger key-board. These combinations could be worked out so that all of the 60 symbols on a typewriter as well as the spacing bar would be represented by various combinations of keys on the 10 finger key-board. For example, the letter "a" might be represented by this key combination:

```
  0 0 0 ■ ■     0 0 0 0 0
L 1 2 3 4 5   R 5 4 3 2 1
```

In order to facilitate the learning and use of such a code it would be necessary to match the most frequently used letters of the alphabet with those combinations of keys which are easiest to manipulate, and the less frequently used letters with the more difficult key combinations.

H. C. Ratz and D. K. Ritchie in a study on "Operator Performance on a Chord Keyboard," published in the Journal of Applied Psychology, 1961, vol. 45, No. 5, pp. 303-308, worked out a chord rank chart of 31 chords ranked according to their difficulty of 'cost' as measured by the reaction time. The apparatus used by Ratz and Ritchie is somewhat similar to that which will be used in our own ERL experiments.



According to the authors, "the relative difficulty of the various chords can be measured in terms of the reaction time in responding on the keyboard to a visual presentation of the chord patterns. Since lights, fingers, and keys are in direct correspondence, the stimulus-response codes are highly compatible, that is, mental recoding of the information is avoided. Thus we obtain an experimental assessment of the performance of an operator using this chosen set of response motor tasks. Using these data and the principles of optimum coding, the more frequently used message units can be assigned to the easier response tasks. This optimum distribution of message units will minimize the average time per message and maximize the rate of information processing.

The final result of their investigation was the development of the following chord rank chart:

Rank	Chord	Rank	Chord
1.	- - - - 0	17.	0 - 0 - -
2.	0 - - - -	18.	0 - - 0 -
3.	- - 0 - -	19.	- - 0 0 0
4.	- - - 0 -	20.	0 - - 0 0
5.	- 0 - - -	21.	0 0 - - 0
6.	0 0 - - -	22.	0 - 0 - 0
7.	0 - - - 0	23.	- 0 - - 0
8.	- 0 0 - -	24.	0 - 0 0 0
9.	0 0 0 - -	25.	- - 0 - 0
10.	- 0 0 0 -	26.	0 - 0 0 -
11.	- - 0 0 -	27.	0 0 - 0 -
12.	- - - 0 0	28.	0 0 0 - 0
13.	0 0 0 0 0	29.	0 0 - 0 0
14.	- 0 0 0 0	30.	- 0 0 - 0
15.	0 0 0 0 -	31.	- 0 - 0 0
16.	- 0 - 0 -		

(The fingers used in the right hand are indicated).

As indicated, this chord rank chart is applicable to the right hand only. A search of the literature indicates that there is no similar kind of study which developes a chord rank chart for the 10 finger key-board. Therefore, for our purposes it will be necessary (due to the absence of information concerning chord ranking using the left hand or both hands together), to make some innovations with the chart above in order to accommodate both hands.

Having decided upon some measure of the level of difficulty of various combinations of keys, it will be necessary to turn our attention to the problem of frequency use of letters of the English alphabet. This problem has already been worked out, and some of the more authoritative findings will be listed here.

Funk and Wagnalls New Standard Dictionary of the English Language (old and recent editions) and the World Almanac of 1942 each present the same findings concerning frequency use of letters of the alphabet.

According to both sources, "the relative frequency in the use of letters of the English alphabet, from observations of printers and typewriters, is said to be as follows":

* LOWER CASE (small letters)

e =	1000	m =	272
t =	770	f =	236
a =	728	w =	190
i =	704	y =	184
s =	680	p =	168
o =	672	g =	168
n =	670	v =	152
h =	540	b =	120
r =	528	k =	88
d =	392	j =	55
l =	360	q =	50
u =	296	x =	26
c =	280	z =	22

UPPER CASE (Capital letters)

S =	1000	R =	244
C =	785	W =	228
P =	673	G =	223
A =	481	U =	191
T =	478	O =	173
D =	423	V =	144
B =	388	N =	128
M =	368	J =	57
F =	325	Q =	49
I =	316	K =	39
E =	285	Y =	19
H =	258	Z =	15
L =	250	X =	4

* World Almanac, 1942, p. 529.
Funk and Wagnalls, 1939, p. 1421.

The results of two other investigators, concerned about the problem in terms of its usefulness in cryptanalysis, will be listed below. Although these charts are not exactly the same as the one previously presented, there is an extremely high correlation among all of them.

Helen F. Gaines in her book, Cryptanalysis, a study of ciphers and their solution, Dover Publications, Inc., New York, 1956, lists the following order and frequency of single letters (compiled from the Meaker diagram chart):

*	e = 1231	p = 229
	t = 959	f = 228
	a = 805	m = 225
	o = 794	w = 203
	n = 719	y = 188
	i = 718	b = 162
	s = 659	g = 161
	r = 603	v = 93
	h = 514	k = 52
	l = 403	q = 20
	d = 365	x = 20
	c = 320	j = 10
	u = 310	z = 9

* Gaines, Helen; Elementary Cryptanalysis, p.219

* Fletcher Pratt in his book, Secret and Urgent, The Story of Codes and Ciphers, The Bodds-Merrill Co., Indianapolis and New York , 1939, lists the following table of frequency of occurrence of letters in English:

LETTER	FREQUENCY OF OCCURRENCE IN 1000 WORDS
1. e	591
2. t	473
3. a	368
4. o	360
5. n	320
6. r	308
7. i	286
8. s	275
9. h	237
10. d	171
11. l	153
12. f	132
13. c	124
14. m	114
15. u	111
16. g	90
17. y	89
18. p	89
19. w	68
20. b	65
21. v	41
22. k	19
23. x	7
24. j	6
25. q	5
26. z	3

* Pratt, Fletcher; Secret and Urgent, p.252.

For our purposes the listing from Funk and Wagnalls and the World Almanac should suffice. The problem now is to match the letter frequency list, in as reliable a way as possible, with the chord ranking chart previously presented.

CHORDS (L 1 2 3 4 5 R 5 4 3 2 1)		Letters + Symbols
- - - - -	- - - - 0	Space
- - - - -	0 - - - -	e
- - - - -	- - 0 - -	t
- - - - 0	- - - - -	a
- - 0 - -	- - - - -	i
- - - - -	- - - 0 -	s
- - - - -	- 0 - - -	o
- - - - -	0 0 - - -	n
- 0 - - -	- - - - -	h
- - - 0 -	- - - - -	r
- - - 0 0	- - - - -	d
- - - - -	0 - - - 0	l
- - - - -	- 0 0 - -	u
- - - - -	0 0 0 - -	c
- - 0 0 -	- - - - -	m
- - 0 0 0	- - - - -	f
- - - - -	- 0 0 0 -	w
- - - - -	- - 0 0 -	y
- - - - -	- - - 0 0	p
- 0 0 0 -	- - - - -	g
- 0 0 - -	- - - - -	v
- - - - -	0 0 0 0 0	b

CHORDS (L 1 2 3 4 5 R 5 4 3 2 1)		Letters + Symbols
- - - - -	- 0 0 0 0 =	k
- - - - -	0 0 0 0 - =	j
- 0 0 0 0	- - - - - =	q
- - - - -	- 0 - 0 - =	x
- 0 - 0 -	- - - - - =	z
- - - - 0	0 - - - - =	,
- - - - 0	0 0 - - - =	.
- - 0 - -	- - 0 - - =	1
- 0 - - -	- - - 0 - =	2
- - - 0 -	- 0 - - - =	3
- - - 0 0	0 0 - - - =	4
- - 0 0 -	- 0 0 - - =	5
- - 0 0 0	0 0 0 - - =	6
- 0 0 0 -	- 0 0 0 - =	7
- 0 0 - -	- - 0 0 - =	8
- 0 - 0 -	- 0 - 0 - =	9
- - 0 - 0	- - - - - =	;
- 0 - - 0	- - - - - =	:
- - - - -	- - 0 0 0 =	?
- - - - -	0 - - 0 0 =	/
- - - - -	0 - - 0 - =	&
- - - - -	0 - 0 - - =	=

CHORDS (L 1 2 3 4 5	R 5 4 3 2 1)		Letters + Symbols
- - 0 - 0	0 - 0 - -	=	+
- 0 - - 0	0 - - 0 -	=	-
- - - - -	0 0 - - 0	=	*
- - - - -	0 - 0 - 0	=	(
- - - - -	- 0 - - 0	=	)
- - - - -	0 - 0 0 0	=	'
- - - - -	- - 0 - 0	=	_
- - - - -	0 - 0 0 -	=	"
- - - - -	0 0 - 0 -	=	½
- 0 0 - 0	- - - - -	=	¢
- 0 - 0 0	- - - - -	=	#
- - - - -	0 0 0 - 0	=	¼
- - - - -	0 0 0 - 0	=	@
- - - - -	- 0 0 - 0	=	%
- - - - -	- 0 - 0 0	=	$
- 0 0 - 0	0 - 0 0 -	=	$\overline{11}$
- 0 - 0 0	0 0 - 0 -	=	∫

A capital letter is made by hitting L 1 plus the combination of keys which comprise the particular small letter. NOTE: There is no combination of keys on the above chart which uses L 1; so that any time L 1 is hit it signifies a capital letter.

SECTION 3.

Selection of Subjects:

Four quite separate and distinct groups will serve as the subjects for the study. These groups, while by no means representative of the population, nevertheless, provide a very heterogeneous sample. If the results of the experiment are found to be consistent and significant with respect to each of these groups, then the results could be assumed to have considerable generality. Use of this four-part sample allows the detection of another possible outcome, namely, that a particular method of instruction is more effective for certain types of learners than for others.

The four classes or groups of subjects are:

1. students who have completed two years of college;
2. unemployed youths, who aside from the fact that they are neither working nor attending school resemble class 1 above;
3. older people in the 45-50 year age range who are interested in job retraining;
4. disadvantaged people, approximately 30 years of age whose work history classes them as unskilled laborers.

Selection of subjects will be performed in two phases. The first phase involves the formation of the classes or groups listed above. The second phase consists of pairing particular individuals within groups. A few more comments about the first phase are in order before turning our attention to the process of pairing individuals.

Groups 1 and 2 are intended to be highly similar groups. Both groups will be made up of youths between the ages of 19-21. Both groups will be heterogeneous with respect to socio-economic level, general learning ability, and performance on a practice period on the 10 finger keyboard prior to the experiment proper to determine the initial ability of the subjects. The essential differences between the two groups will consist of differences in: academic attainment (members of Group 2 will lack college training); drive and stability (members of Group 2 will be chosen to have what might be designated a poor work history, considerable number of job changes, relatively long periods of unemployment, etc.).

Groups 3 and 4 are expected, by virtue of the way these groups have been defined, to be relatively homogeneous as regards socio-economic level. Stated differently, the members of these groups are very likely to be poor people whose standard of living is low. They are also by definition, more mature in age than Groups 1 and 2. It is, however, anticipated that both groups will vary considerably with respect to general learning ability and initial ability on the 10 finger keyboard.

APPENDIX B.

Quarterly Progress Report No. 2

NEW YORK INSTITUTE OF TECHNOLOGY

APPLIED RESEARCH LABORATORY

Quarterly Progress Report No. 2

for an

EXPERIMENTAL PROGRAM

on

EQUIVALENT RESPONSE LEARNING TECHNIQUES

Contract No. OE-5-85-070

submitted to:

Division of Vocational and Technical Education
Office of Education
U. S. Department of Health, Education, and Welfare
Washington, D. C. 20202

period covered:

August 1, 1965 through October 31, 1965

submitted by:

Theodore K. Steele, Eng.Sc.D.
Principal Investigator

A B S T R A C T

Under the above contract, the Applied Research Laboratory of the New York Institute of Technology is continuing an experimental program on Equivalent Response Learning Techniques with the objective being to identify the effectiveness of ERL techniques in the human learning process with special attention devoted to the potentialities for training and retraining of unemployed youths, of older workers, and of disadvantaged sections of the population. The activity level during this report period was kept at a minimum because of the limited funds available pending the receipt by ARL of the finalized contract. The contract was received in mid-October whereupon steps were taken to fabricate and purchase components making up the teaching aides for the ERL Technique Test System. It is planned to complete this Test System during the next quarter.

R E P O R T

The activities of the New York Institute of Technology Applied Research Laboratory for the period from August 1, 1965 through October 31, 1965 were kept at a minimum because of limited available funds pending the receipt of the finalized contract. The executed contract did arrive in mid-October at which time steps were taken to release purchase orders for equipment and parts requiring fabrication.

The circuitry for the comparison logic system was modified slightly to simplify functioning and these changes were included in the released purchase orders. A prototype of the key illustrated as Figure 4 (page 10) in Quarterly Progress Report No. 1 is currently being prepared by the Meadowbrook Precision Instruments Corp. of Merrick, L. I., New York. When the prototype key is deemed to be functionally operational, an intermediate quantity of five or ten will be ordered so as to be able to incorporate the necessary keys in a prototype "subject console". A total quantity of fifty keys will be required to make up the five "subject consoles" for the program.

The parts for the "experimenter's console" will be purchased and assembled so that by the end of the forthcoming report period, a pilot run using the prototype "subject console" and "experimenter console" can be effected. The tests will be run on a carefully selected group of lower classman students at the New York Institute of Technology whose backgrounds will be sufficiently close to those of the anticipated non-college subjects. In this manner, the de-bugging phase of the teaching aide equipment can be accomplished in the least amount of elapsed time.

Work has continued on the establishment of the research subjects. While the students are readily available, a problem exists with regard to timing in the use of unemployed youths, older people, and disadvantaged people. Discussions with the Assistant Director of Public Relations of the New York State Employment Agency indicate that the availability of the latter categories of subject personnel are transient by nature since they tend to gravitate toward any available job. It is therefore critical to time their participation in the subject program judiciously so as to have them available for at least two to three weeks continuously. The New York State Employment Agency indicated that they would process our requests for specific research subjects just as if they were regular job orders. The onus will be on us to see that the research subjects chosen can be brought back either evenings or weekends, should they later become employed, so that the retentivity tests can be concluded.

APPENDIX C.

Quarterly Progress Report No. 3

5-0006

NEW YORK INSTITUTE OF TECHNOLOGY

APPLIED RESEARCH LABORATORY

Quarterly Progress Report No. 3

for an

EXPERIMENTAL PROGRAM

on

EQUIVALENT RESPONSE LEARNING TECHNIQUES

Contract No. OE-5-85-070

submitted to:

Division of Adult and Vocational Research
Bureau of Research
U. S. Department of Health, Education, and Welfare
Washington, D. C. 20202

period covered:

November 1, 1965 through January 31, 1966

submitted by:

Theodore K. Steele, Eng.Sc.D.
Principal Investigator

A B S T R A C T

Under the above contract, the Applied Research Laboratory of the New York Institute of Technology is continuing an experimental program on Equivalent Response Learning Techniques with the objective being to identify the effectiveness of ERL techniques in the human learning process with special attention devoted to the potentialities for training and retraining of unemployed youths, of older workers, and of disadvantaged sections of the population.

During this report period, a prototype of the "subject console" was completed and sampled to check ease of operation. Several minor design changes were instituted to utilize smaller and simplified components. The revised model is now completed and parts for five complete "subject consoles" have been procured.

The design for the "experimenter console" has been simplified considerably and is described in the body of the report.

Regarding the administration of the subjects, a meeting with the principals of the Board of Education Job Counseling Center of New York City was held. It appears that this group can play a prominent role in the administration of disadvantaged youths, drop outs and to some degree older workers seeking retraining.

It is hoped to have all the teaching aides completed during the next report period and first samples of student reactions observed.

I N T R O D U C T I O N

During this report period, prime consideration was given to the finalization of the two major teaching aides and to the ways and means for administering the various categories of research subjects.

SECTION 1 of this report describes the changes instituted in the "subject console" based upon the experience gained after cycling the first model. It also includes the revised design of the "experimenter console" which took into account primarily the need for a highly reliable functioning device capable of withstanding day-to-day use with a minimum of maintenance.

SECTION 2 introduces the available facility of the New York City Board of Education Job Counseling Center and the role they may be able to play in the administering of several of the research subject categories.

SECTION 1.

Equivalent Response Learning Technique Test System

The ERL Test System presented in Quarterly Progress Report No. 1 has been modified to some extent based on the premise that the teaching aides should be as functionally simple as possible in order to stand the rigors of day-to-day operation with a minimum need for maintenance.

The first model of the "subject console" was completed and preliminary tests for ease of operation were undertaken. The layout of the finger configuration was found to be awkward particularly with respect to the thumb. This was ameliorated by offsetting the thumb from the other finger positions and increasing the size of the key significantly.

A measure of safety was also introduced by reducing the operating line voltage to twenty-four (24) volts D.C. by introducing an appropriate power supply. This change also allows the console to be operated by a battery power supply should such "portable" operation be desired.

A problem was encountered with the solenoids operating the stimulation of the keys. It was found that the ratings listed in the manufacturer's catalog were in error and it was necessary for them to be replaced by more powerful ones. A photograph of the prototype "subject console" is included herein.

Sufficient parts for the assembling of five complete "subject consoles" have been procured and their assembly will be achieved very shortly.

A review of the design of the "experimenter's console" was undertaken to assure no possibility of overlapping of any of the sequential events. One possible difficulty discovered was the critical nature of the "manual advance switch". Figure 2, Revision A indicates the restraint imposed on this switch by having it remain in a closed position for a time duration equal to or greater than the sum of the time delays governing the "pulse generator" and the "new relay".

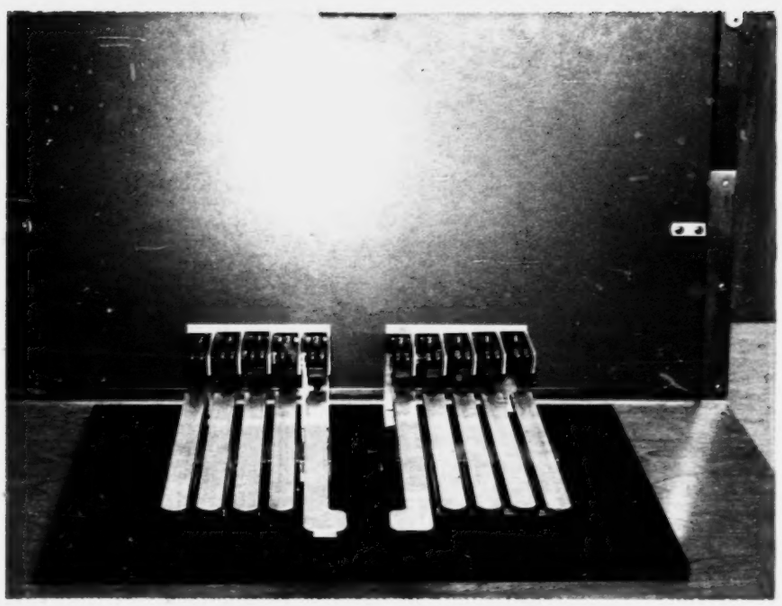
The former "error relay" in Figure 3 has been inverted to become a "non-error relay" with the circuitry appropriately adjusted in Figure 3, Revision A.

The former "error punch" has been replaced by an "error light" to simplify the design. This will require the experimenter to participate in some nominal notation of errors rather than have the task done automatically. This would not be too difficult to accomplish considering the small number of subjects being tested at one time (maximum of five).

A Bill of Materials reflecting the component parts needed for the "experimenter's console" is included herein.

Calculations for a one-shot multivibrator timer are also provided.

During the next report period it is expected that the two consoles will be completed and first sample tests undertaken using NYIT students as subjects.



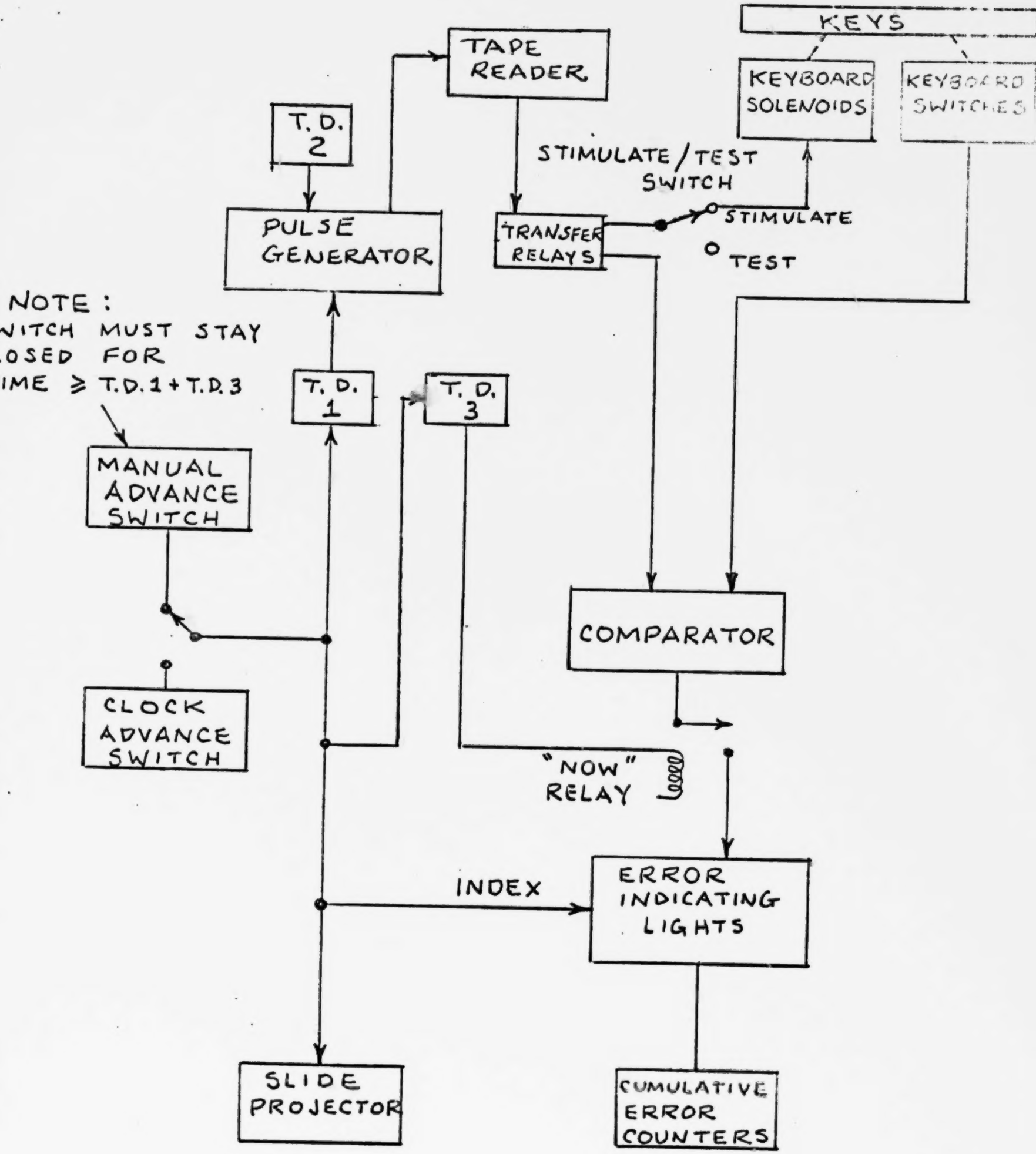
- Subject Console Photo -

TKS
2/

FIGURE 2 (REV. A)

FUNCTIONAL BLOCK DIAGRAM

ERLT TEST SYSTEM

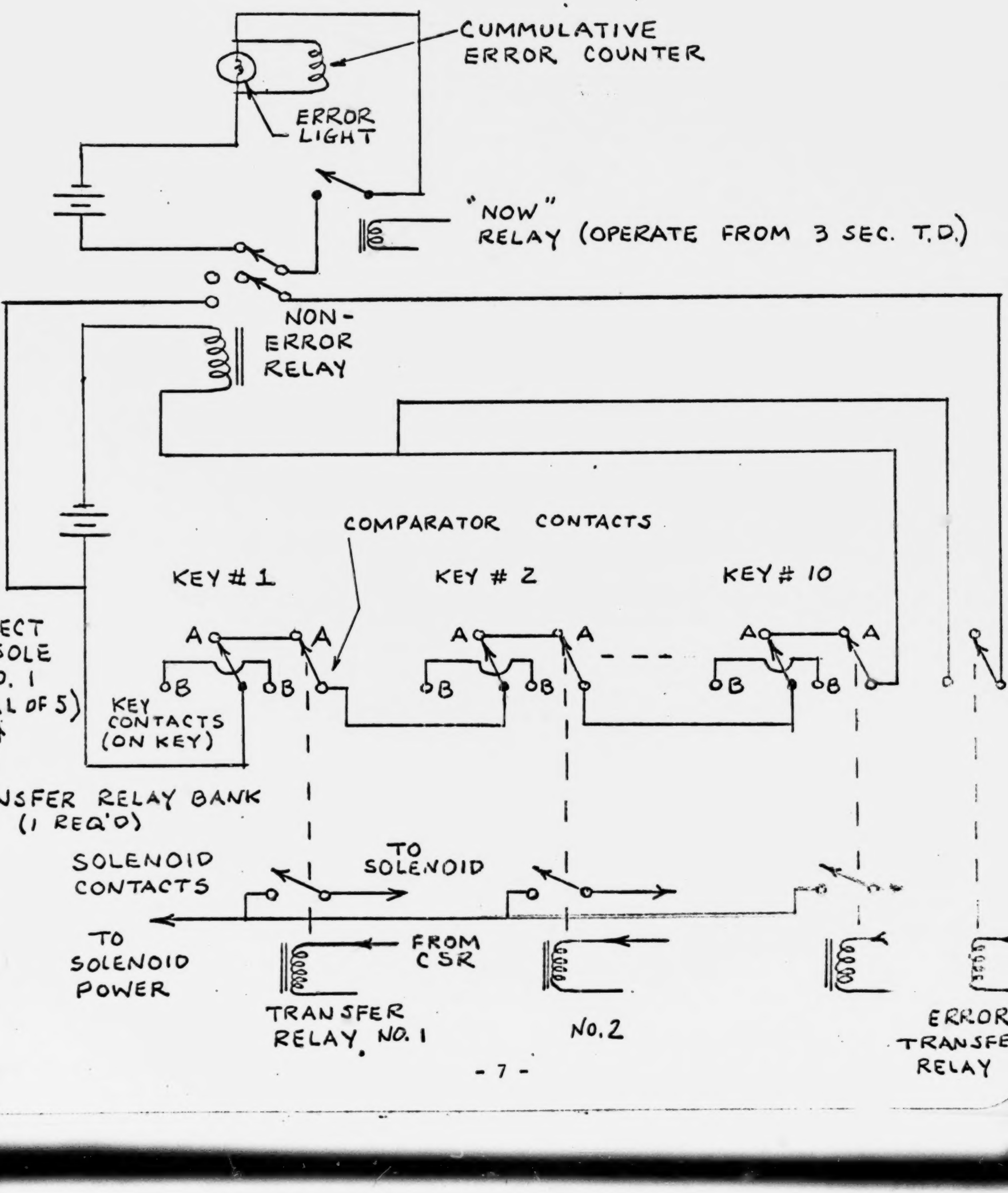


TR5
2/1/66

FIGURE 3 (REV. A)

COMPARISON LOGIC CIRCUIT DIAGRAM

ERTL TEST SYSTEM



MEADOWBROOK *Precision Instruments Corp.*

2 NORTH HEWLETT AVENUE · MERRICK, NEW YORK · MAYFAIR 3-3710

February 15, 1966

New York Institute of Technology - Contract No. OE-5-85-070

BILL OF MATERIALS

Description	Quantity Required
Tape Reader, Ohr-tronics Model 119R	1
Slide Projector, Kodak	1
Error Counters, Eagle Signal PCC-7	5
Clock Driven Switch, Haydon RB2102-1M	1
Manual Advance Switch, Switchcraft 27312	1
Stimulate-Test Switch, C-H 8282K13	2
Time Delay Relay	3
Power Supply, 24 V. 25 A	1
Transfer Relays, 5 PDT	11
Transfer Relays, DPDT, KRP11D	5
Terminal Strips, C-J 141-12	6
Terminal Strips, C-J 140-22	6
1000 ft. #16 Ga. PVC Wire	1 Spool
1000 ft. #20 Ga. PVC Wire	1 Spool
Tables	5
Instructor's Table	1
Chairs	6
Miscellaneous Components	

ERIC at Stanford is using postcards like this to try to speed-up communication.

Pages 9-11 of Quarterly Report #3 opaqued because of illegibility. These are handwritten equations.

SECTION 2.

Administration of Research Subjects

On January 17, 1966, Mr. Thomas and Dr. Steele of NYIT met with Messrs. Richard Greenfield and Seymour Weisman, Director and Administrative Counselor of the N.Y.C. Board of Education Job Counseling Center, to discuss the latter's possible participation in the ERL techniques research program.

The Job Counseling Center has served the 16 to 21 year old out-of-school unemployed youth since February 1964. The Center operates under a grant from the Office of Manpower, Automation and Training of the United States Department of Labor. To date over 3,000 disadvantaged youth have been involved in their program of counseling, work try out, remediation, placement, post-placement counseling and follow-up. They have used their resources as well as those of other Board of Education facilities such as the Manpower, Development and Training Act "Umbrella", the Trade Extension program, and Day and Evening School programs. The major features of their program are as follows:

(1) They believe in rapid job placement since the other components are more effective after the immediate need for employment is met.

(2) Their staff are all specially selected licensed Board of Education personnel (counselors, voc-ed teachers, remedial reading specialists, teachers with job development experience).

(3) They do their own job development and placement and have made more than 2500 placements. For many of their youth, they have made multiple placements since many youngsters have often lost their first jobs.

(4) The centers are open in the evening to provide the bulk of service after placement. Almost all youth are working within a week or ten days after intake. This period allows three or four pre-employment counseling sessions.

(5) The long term aim of the program is to encourage the youth by post-placement efforts to build on the solid base of present employment through involvement in a variety of activities leading to his upgrading.

With this profile, it is clear that the Job Counseling Center is more than qualified to serve as a source of research subjects particularly those in the categories of school dropouts, from socially disadvantaged families and having difficulties holding a position for any length of time.

When the teaching aides are operational, another meeting will be held with Messrs. Greenfield and Weisman to put into play their direct participation in the ERL program.

The problem of subjects in the category of 45 years or older seeking retraining is somewhat more severe. One approach recently pursued by Dr. Steele is that of working with establishments such as "Office Temporaries" which have lists of older personnel (primarily women) seeking to re-enter the labor market after many years away primarily as housewives. This will be followed up and may prove to be fruitful particularly in the specific area of keypunch oriented vocations.

APPENDIX D.

Quarterly Progress Report No. 6

ERD-187
(5-00006)

NEW YORK INSTITUTE OF TECHNOLOGY

APPLIED RESEARCH LABORATORY

Quarterly Progress Report No. 6

for an

EXPERIMENTAL PROGRAM

on

EQUIVALENT RESPONSE LEARNING TECHNIQUES

Contract No. OE-5-85-070

submitted to:

Division of Vocational and Technical Education
Office of Education
U. S. Department of Health, Education, and Welfare
Washington, D. C. 20202

period covered:

August 1, 1966 through October 31, 1966

submitted by:

Theodore K. Steele

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Principal Investigator

(1) During the quarter from August 1, 1966 through October 31, 1966, the teacher aide system comprising an "experimenter's console" and five "student consoles" were delivered from the Meadowbrook Precision Instruments Corp., Merrick, New York to the New York Institute of Technology facility at Pacific Street in Brooklyn, New York. It was felt that this metropolitan location situated at a convenient interchange of most public transportation systems in New York City would best suit the needs of the experimentee population.

Subsequent to the delivery and installation, considerable time was spent on a de-bugging phase so as to assure the experimenters of a highly reliable functioning system and minimize confusion as to whether an observed error was "human-made" or "machine-made."

A wide variety of types of experimental personnel were subjected to arbitrary test schemes to determine human reaction to the mode of experiment. The population included technicians, students, unskilled laborers and teachers at different age levels. No scores were kept but their reactions to key action, speed of code presentation, stimulation, response and duration of comfort were observed.

(II) After the completion of the above referenced informal tests, a preliminary pilot study was performed to determine the effectiveness of the equipment, to devise some finalized procedures for selecting subjects, to determine the most feasible training regimen, and in addition to gain some empirical notions concerning the method of presenting information to both the experimental and control groups.

A) METHODS OF SELECTION

The pilot group consisted of 8 subjects, specially selected because of the relative homogeneity of their socio-economic backgrounds and intelligence. The 8 subjects are part of a larger group of students who are participating in a special project at N.Y.I.T. sponsored by a Ford Foundation grant. The purpose of this special project is to afford the opportunity of a college education to certain students, who, for various reasons including lack of funds or sufficiently high academic achievement, would otherwise not be in a position to attend college.

In effect, a dual selection procedure was established at least in so far as the ERL pilot study was concerned. The students were first screened by various neighborhood and community groups. Finalized testing and selection was conducted at N.Y.I.T.

The 8 subjects who participated in the first phase of the pilot study were selected from this special group of students. In addition, a brief questionnaire was completed by each student, requesting specialized information concerning their previous experience with typing, key-punch operation, piano playing, or any other related skills.

Finally, the students were administered the C.Q.T. (College Qualification Tests: Combined Booklet Edition; Form A, N.Y.: The Psychological Corporation). The subjects finally selected for work on the ERL pilot study were homogeneous to the extent that their combined scores were below the 30th percentile (Norms for high school students in Grade 12).

In the actual experimental phase of operations with the ERL technique, it is anticipated that an additional measure, namely actual pre-test experience on the ERL equipment will form an integral part of the selection and matching procedure.

Also, in view of the fact that of this pilot group of 8, all had graduated from high school and, although undertaking a special upgrading remedial program, all are considered members of the freshman class at N.Y.I.T., the C.Q.T., which correlates favorably with most measures of intelligence, could be used in lieu of such a measure.

However, for those large number of subjects who will participate in the ERL experiments in the near future, and who will not constitute a college group but instead will be representative of that group which has not characteristically

had much success in school, i.e., high school dropouts, unemployed adults with little or no skills in terms of employment, it will be necessary to use some other measure than the C.Q.T. in order to select and match according to intelligence.

The variables for selecting and matching subjects currently number six.

1) Socio-economic background
2) Age
3) Sex
4) Intelligence
5) Previous experience on similar kinds of equipment using related skills
6) Actual test experience on the ERL equipment

	Information Desired		Information Obtained By
1)	Age	)	
2)	Sex	)	
3)	Socio-economic background	)	Questionnaire
4)	Previous experience, or related skills	)	
5)	Intelligence	-	Some valid and reliable I.Q. measure
6)	Actual experience on ERL equipment	-	Pre-matched measured experience on actual equipment

Accurate information in all of these areas should facilitate the valid selection and matching of subjects.

Because of the nature of this preliminary pilot study, no attempt was made to test the hypothesis, measuring the experimental against the control condition. Basically, this was a test of equipment and procedure, so consequently, no comparative results are listed in this report.

The 8 subjects who participated in this pilot study consisted of 6 boys and 2 girls, all within the ages of 18 and 21, selected and matched (4 in each condition) according to the criteria previously outlined.

B) TRAINING REGIMEN

The training regimen consisted in learning to associate 4 different combinations of keys with 4 different numbers. The symbolic material was presented in consecutive sequence from #1 to #4, and then repeated again, and so on, for a period of 30 min. on three different occasions.

C) METHOD OF PRESENTING INFORMATION

During the pilot study, the 4 numbers and their respective codes in the experimental condition were presented by means of a slide projector with slides indicating the correct combination of keys to be depressed. This was followed immediately by the

elevation of the appropriate keys, corresponding to the key combination indicated on the screen. The time delay between the visual presentation of information via the projected slides and the elevation of the keys was about 3 seconds. This time delay can be varied to suit the need of the experimenter.

In the control condition, the information was presented via the slides projected upon a screen, but without the elevation of the keys. In order to validly measure the effect of the independent variable (sensory stimulation caused by elevating keys), it is essential to hold constant all other factors dealing with the method of presenting information. It was necessary during these preliminary trials to present the information in this manner in order to determine the reliability of the equipment.

During the measured experiments, the material will be presented somewhat differently. The slides in the experimental condition will indicate only the symbol (number or letter) to which the subsequently elevating keys will correspond. This procedure will be introduced in lieu of presenting, in the form of slides, not only the symbol (number or letter) but also its corresponding code. The latter procedure was used in the pilot study only as a test of equipment reliability. This procedure should facilitate the isolation of the independent

variable (stimulus provided by elevating keys) for accurate appraisal.

D) **TESTING**

In the preliminary pilot study, a post-test was administered immediately following the completion of the first trial. A pre-test preceeded trial 2 on the second day and trial 3 on the third day, with both these trials being followed by a post-test.

Testing is accomplished by presenting only the symbol (letter of number) upon the screen, requiring the subjects to depress those keys which signify that symbol. The testing procedure must be the same for both experimental and control groups so that there is no stimulation whatsoever in any test situation.

During the actual experimentation, this same procedure will be adhered to, with some additional tests of retention to be administered at designated intervals after the completion of the training.

E) **STATISTICAL ANALYSIS OF RESULTS**

The equipment for the ERL experiment has been designed to record only the errors which are made by the subjects. A correct response does not permit an error to be recorded on the error counter. Consequently, assuming that both the experimental

and control groups are equivalently matched, and are being administered exactly the same training regimen, a record of the errors made by both groups will provide a valid and simple means of measuring one group against the other. It will be necessary to determine mathematically whether or not and to what extent such differences (if any) could be due to chance.

The error count for both groups will be recorded during the actual training, and also in the test situations. Reports concerning the amount of errors made will be provided for both experimental and control groups and in addition, for individual subjects within both those groups.

F) FINAL OBSERVATIONS AND CONCLUSION

This report has resulted from observations made during the preliminary pilot study combined with the experimental design which was submitted on the 1st quarterly report in the Fall of 1965.

During the preliminary study, this investigator was most sensitive to the progress of the subjects and especially their verbal reports concerning their reactions to the equipment.

It was noted on the basis of the performance and verbal reports of the subjects that fatigue does set in after approximately 30 minutes at the consoles.

On one occasion, one of the subjects indirectly suggested a procedure which seemed to mitigate against pre-mature fatigue. During one of the trials in the control condition, as the #1 and its corresponding code was flashed upon the screen, some electrical interference reduced the amount of time that that particular slide remained projected upon the screen. Consequently, instead of the code being presented for 3 seconds, the interference in this particular trial caused the code to be flashed for only 0.5 seconds. The result was that the subjects had limited time to make the correct association and respond. Interestingly enough, there were no errors recorded for any of the subjects during that trial. And, as the subjects were about 25 minutes into that particular training session, fatigue and boredom seemed to be developing. After this unexpected decrease in the time of visual presentation of information, the subjects became more alert and responsive, perhaps assuming that on the next trial they would have even less time to respond.

The fact that this caused them to pay increased attention to the information being presented was dramatically illustrated to this investigator by a comment made by one of the subjects at the completion of that day's trials, to the

effect that he now assumed that a test was also being made of how rapidly they (the subjects) could respond to quick flashes of information. In other words, he assumed that what resulted from electrical interference was actually part of the training procedure, the purpose of which was to test the reaction time of the subjects especially after a previous pattern had been developed in terms of their response. (In all of the other trials the slides were uniformly flashed upon the screen for 3 seconds.)

On the basis of this incident, it can be concluded that in order to mitigate against fatigue and boredom during actual training, it will prove most advantageous to introduce some element of variety (at least in terms of time duration) into the presentation of information.

Valuable information such as that reported above can only be obtained empirically during actual training sessions. Such was the rationale for undertaking the preliminary pilot study described in this report. And in terms of supplying some empirical information, the study was extremely helpful.

(III) Although during the course of the above-mentioned pilot experiments, no statistical data were recorded for actual publication, the raw scores for each of the five student stations were noted as part of the calibration of the teacher aide system. Consistent errors were noted at certain

machines for specific codes to the extent that the confidence level of human error versus machine error could still be questioned. In subsequent checks of the system wiring, several marginal open circuit conditions were found which could have caused the discrepancies noted. These could have resulted from the transport of the equipment.

As a result of these questionable conditions, all experiments have been temporarily suspended and a detailed checkout of all fifty keys is currently underway.

At the conclusion of this final checkout, formal experiments involving the eight subjects mentioned above will be conducted.

Other types of experimental subjects will be gathered during the next quarter so that the experimental phase of the project can be accelerated.

(IV) Paperwork providing for the extension of the contract termination date from October 31, 1966 to May 31, 1967 at no additional cost were received during this quarter. The program is being continued on the basis that such an extension will be finalized.

APPENDIX E.

Quarterly Progress Report No. 8

#5-0006

NEW YORK INSTITUTE OF TECHNOLOGY

APPLIED RESEARCH LABORATORY

Quarterly Progress Report No. 8

for an

EXPERIMENTAL PROGRAM

on

EQUIVALENT RESPONSE LEARNING TECHNIQUES

Contract No. OE-5-85-070

submitted to:

Division of Vocational and Technical Education
Office of Education
U. S. Department of Health, Education, and Welfare
Washington, D. C. 20202

period covered:

February 1, 1967 through April 30, 1967

submitted by:

Theodore K. Steele, Eng.Sc.D.
Principal Investigator

The major expenditure of time, during this report period, was spent on rewiring the troublesome link between the teacher aide power supply and the student consoles. As mentioned previously, the coupling was simplified to a great extent but the myriad wires and components required a major trouble-shooting phase to assure functional reliability of the overall system.

By the middle of April, limited testing of some subjects was resumed primarily concerned with the study of techniques for developing patterns for the Equivalent Response Learning process.

A small group of students, who may be characterized as disadvantaged youths engaged in pre-collegiate education, were the subjects of some specially designed pre-tests on the redesigned aide equipment. They filled out appropriate questionnaires which included information relevant to matching pairs of test subjects. The specific information included:

(1) Education background
(2) Job experience
(3) Previous exposure to related types of equipment

Five of these subjects took part in this pre-test. The teacher aide equipment was set in the stimulate mode which provided for the activation of the proper keys which in turn required appropriate responses.

The tests were brief (about two minutes in duration) and comprised some twelve combinations of keys starting with relatively simple levels of complexity and becoming more difficult as the test progressed.

The objectives of the tests were to obtain information relative to:

(1) Finger dexterity;
(2) Hand-eye coordination;
(3) Ability to respond with speed while at the same time depressing only those keys which had been activated.

The combination of the information drawn from the questionnaire and the results of a yet more extensive pre-test will form the basis for establishing the matching procedure.

Unfortunately, the equipment did exhibit some minor malfunctioning as the tests progressed which limited proceeding beyond the aforementioned twelve combinations of keys.

The proposed full pre-test will consist of some twenty-six key combinations with the students tested in both the stimulate and non-stimulate modes. This procedure will allow for an increasing level of key-combination complexity as the test progresses. The different modes of operation will bring to bear different kinds of skills which will provide useful information

in the matching process. The stimulate condition requires finger dexterity and the ability to respond with speed to perform the task. On the other hand, the non-stimulate condition draws primarily on the subject's competence in hand-eye coordination since he views a visual presentation of the key combinations to which he must respond by depressing the proper keys in order to complete the task.

It is felt that scores for both these conditions should yield valuable information relative to the suitable matching of subject pairs.

The limited pre-test scores for the five subjects mentioned above are as follows:

Subject No.	Score on Pre-Test (Maximum score = 12)
1	10
2	9
3	5
4	7
5	6

It should be noted that with 26 key combinations used in two different modes will provide a maximum score of 52 in the proposed pre-test operation. Even with these limited tests, it should be noted that there was a sharp individual difference in the scores. This can be correlated to definite individual differences in ability.

The pre-test system proposed is easy to run and easy to score.

Work is continuing on the trouble-shooting of the rewired system so that meaningful data on actual ERL tests can be obtained.

It is hoped that the request to continue the program, with no additional funds required, beyond the May 31, 1967 deadline will be approved. The summer months will allow us to reach several kinds of subjects normally not available during an academic year.